भारतीय मानक **IS 1121 (Part 1) : 2023**

Indian Standard

प्राकृतिक इमारती पत्थर के सामर्थ्य गुणों को ज्ञात करना — परीक्षण पद्धतियाँ

भाग 1 अक्षीय संपीड़न क्षमता

(तीसरा पुनरीक्षण)

Determination of Strength Properties of Natural Building Stones — Methods of Test

Part 1 Uniaxial Compressive Strength

(Third Revision)

ICS 91.100.15

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November 2023 **Price Group 5**

Stones Sectional Committee, CED 06

FOREWORD

This Indian Standard (Part 1) (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Stones Sectional Committee had been approved by the Civil Engineering Division Council.

Building stones are available in large quantity in various parts of the country and to choose and utilize them for their satisfactory performance, it is necessary to know the various strength properties determined according to standard procedure. This standard has therefore, been formulated to cover the standard method for determining the strength properties of various stones. This standard covering compressive, transverse and shear strength properties was published in 1957 and was subsequently revised in 1974 and in 2013. The revision in 1974 was issued in four parts; other parts being:

Part 2 Transverse strength
Part 3 Indirect Tensile strength
Part 4 Shear strength

All four parts of IS 1121 are being revised. In doing so, another part namely, Part 5 'Flexural modulus of elasticity' is being introduced.

In this revision the major modifications incorporated are as follows:

a) Provision for taking core sample has been included;
b) The size of the required test specimen has been modified;
c) The plane of anisotropy has been explained;
d) The correction factors to be applied in case of conducting the test with a specimen of non-standard size has been added; and
e) A sample test report has been included.

This standard contributes to the United Nations Sustainable Development Goal 11 'Sustainable cities and communities' towards strengthening the efforts to protect and safeguard the world's cultural and natural heritage.

The composition of the Committee responsible for formulation of this standard is given in Annex B.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

DETERMINATION OF STRENGTH PROPERTIES OF NATURAL BUILDING STONES — METHODS OF TEST

PART 1 UNIAXIAL COMPRESSIVE STRENGTH

(Third Revision)

1 SCOPE

This standard (Part 1) lays down the procedure for determination of uniaxial compressive strength of natural building stones used for constructional purposes.

2 REFERENCES

The standards given below contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards:

IS No.	*Title*
IS 1121 (Part 2) : 2023	Determination of strength properties of natural building stones — Methods of test: Part 2 Transverse strength (*third revision*)
IS 9179 : 1979	Method for preparation of rock specimen for laboratory testing

3 SELECTION OF SAMPLES

3.1 The sample shall be selected to represent a true average of the type or grade of stone under consideration.

3.2 The sample shall be selected from the quarried stone or taken from the natural rock, as described in **3.2.1** and **3.2.2** and shall be of adequate size to permit the preparation of the requisite number of test specimens. Sample can also be selected from core sample transported from the site, collected during investigation.

NOTE ─ The sample size, if cuboidal, shall not be less than 30 cm side; and if drilled, shall not be less than 15 cm length.

3.2.1 *Stones from Ledges or Quarries*

The ledge or quarry face of the stone shall be inspected to determine any variation in different strata. Differences in colour, texture and structure shall be observed. Separate samples of stone of adequate size of the unweathered specimens shall be obtained from all site strata that appear to vary in colour, texture and structure. Specimens that have been damaged by blasting, driving wedges, heating, etc, shall not be included in the sample.

3.2.2 *Field Stone and Boulders*

A detailed inspection of the stone and boulders over the area shall be made where the supply is to be obtained. The different classes of stones and their conditions at various quarry sites shall be recorded. Separate samples for each class of stone that would be considered for use in construction as indicated by visual inspection, shall be selected.

4 TEST SPECIMENS AND CONDITIONING

4.1 Test specimens shall be made from samples selected in accordance with **3** and shall be in the form of cubes or right circular cylinders. They shall be cut or drilled from the samples. The diameter or lateral dimension (distance between opposite vertical faces) of a test specimen shall not be less than 50 mm or 10 times the size of the largest mineral grain present in the rock, whichever is greater and the ratio of height to diameter or lateral dimension shall not be less than 1 (*see also* **7.2**).

NOTE — Test specimens prepared out of broken beams in the transverse test [*see* IS 1121 (Part 2)] may also be used.

4.2 The load-bearing surfaces of the test sample shall be prepared in accordance with **6** of IS 9179.

4.3 The load-bearing surfaces and the direction of the plane of anisotropy like joints, foliation, cleavage, rift, bedding, etc shall be carefully marked on each test specimen after finishing.

NOTE ─ If required, the sample may be wetted to assist in identifying the plane of anisotropy.

4.4 Five test specimens shall be used for conducting the test in each of the conditions mentioned in **4.4.1** and **4.4.2**. In each of these conditions, separate tests shall be made for the specimens when the load applied is parallel to the plane of anisotropy like joints, foliation, cleavage, rift or bedding and perpendicular to the plane of anisotropy (*see* Fig 1). In all, 20 test specimens shall be used.

4.4.1 The test specimens shall be saturated by vacuum saturation by immersing in water maintained at 20 °C to 30 °C in an evacuation vessel under a vacuum of about 50 mm of Hg to 100 mm of Hg. Specimens shall be initially immersed continuously for about 4 h to 5 h in vacuum and then its mass measured at an interval of 1 h (samples being replaced back in evacuation vessel after weighing) till constant mass. Constant mass is considered to have been achieved when two consecutive hourly measurements of mass do not vary by more than 0.1 percent of the saturated mass. Vacuum may be created by a suitable air suction pump.

4.4.2 The test specimens shall also be tested in dry condition and shall be dried in an oven at 70 °C ± 5 °C for 48 h and cooled in a desiccator to room temperature (20 °C to 30 °C) to constant mass. Constant mass is considered to have been achieved when two consecutive hourly measurements of mass do not vary by more than 0.1 percent.

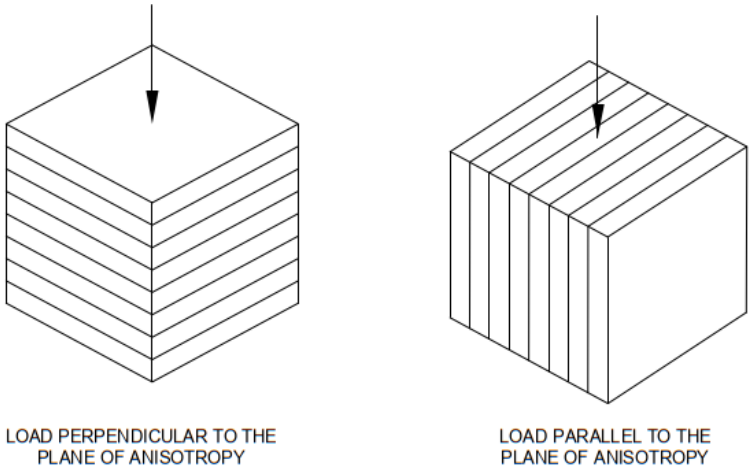

FIG. 1 ANISOTROPIC PLANES IN NATURAL STONES

5 APPARATUS

A testing machine of appropriate capacity for the tests and capable of applying load at the specified rate shall be used. The machine shall be equipped with two steel bearing plates with hardened faces. One of the plates (preferably the one that normally bears on the upper surface of the test specimens) shall be fitted with a ball seating in the form of a portion of a sphere, the centre of which coincides with the central point of the face of the plate. The other compression plate shall be a plain rigid bearing block. The bearing faces of both plates shall be preferably larger than the nominal size of the test specimen to which the load is applied. The bearing surface of the plates when new, shall not depart from a plane by more than 0.012 5 mm at any point. The movable portion of spherically seated compression plate shall be held on the spherical seat, but the design shall be such that it is possible to rotate the bearing face freely and tilt it through small angles in any direction.

6 PROCEDURE

The load shall be applied continuously without shock and increased at a constant stress rate such that failure will take place in about 5 min to 15 min of loading. Alternatively, the stress rate shall be within the limits of 0.5 MPa/s to 1.0 MPa/s. The load shall be applied until the resistance of the test specimen to the increasing load breaks down and no greater load is sustained. The maximum load applied to the test specimen shall be recorded nearest to 0.1 kN and the appearance of the stone and any unusual features in the type of failure shall be noted.

7 EVALUATION AND REPORT OF TEST RESULTS

7.1 The maximum load (in N) supported by the test specimen before failure occurs, divided by the area of the bearing face of the specimen (in mm^2) shall be taken as the uniaxial compressive strength of the specimen.

7.2 When the ratio of height to diameter (or lateral dimension) is between 1 and 2, the result shall be calculated to that standard test specimen as follows:

$$UCS_s = \frac{UCS_{ns}}{0.778 + 0.222\,(b/h)}$$

where

UCS_S = uniaxial compressive strength of standard testspecimen, in MPa;

UCS_{ns} = uniaxial compressive strength of the specimen having a height greater than the diameter or lateral dimension in MPa;

b = diameter or lateral dimension, in mm; and

h = height, in mm.

Using the same equation, uniaxial compressive strength for sample having $b/h = 0.5$, will be, $UCS_s = 1.125 \times UCS_{ns}$

7.3 The individual and average of the five valid test results in each condition separately (*see* **4.4**) shall be taken for purposes of reporting the uniaxial compressive strength of the sample. The test results shall be considered valid when the individual value has a variation within ± 15 percent of the average test result. Additional samples shall be tested to replace the invalid test result. However, all the results (valid and invalid) shall be reported.

7.4 The uniaxial compressive strength shall be expressed in MPa up to 3 significant figures.

7.5 Identification of the sample, date when sample was taken and type of stone shall be reported.

7.6 Size and shape of test specimens used in the tests shall be indicated. A sample format of test report is attached at Annex A.

Annex A

(*Clause* 7.6)

SAMPLE FORMAT FOR OBSERVATION TABLE FOR UNIAXIAL COMPRESSIVE STRENGTH TEST OF STONES

Inward No. : Sample no : Date :

Sample pre-treatment for saturated conditions :

Sub sample no.	Mass of sample in saturated surface wet condition				Final mass in SSD condition
	1	2	3	4	
01					
02					
10					

Sample pre-treatment for dry conditions :

Sub sample No.	Mass of sample in hot condition				Final mass after cooling
	1	2	3	4	
11					
12					
20					

Test in dry/wet condition for load applied parallel/perpendicular to the plane of foliation, cleavage, rift or bedding.

Shape of Sample : Cube/Cylinder

Sub sample No.	Bearing surface area mm × mm (A)	*Max* compressive load for failure (P)	Uniaxial compressive strength in N/mm^2 (P/A)	Validity* of result Yes/No	Average uniaxial compressive strength of 5 valid result
01					
02					
20					

* Valid results are those which falls within average of 5 results ± 15 percent.

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITON

Stones Sectional Committee, CED 06

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